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1

A FRICTION MEMBER AND A METHOD FOR ITS SURFACE TREATMENT

The present invention relates to a method for surface treatment of friction members like brake discs, drums, clutch parts and more particularly to treatment of PMMC based members and further to thereby provided friction members.

Conventional brake discs are presently made of ferrous alloys/cast iron having satisfactory performance and maintaining operative even at substantially elevated temperatures up to above 700°C.

However, the present tendency in the automotive industry to reduce the total weight of vehicles challenges new lighter materials to penetrate also this particular segment of vehicle construction. Furthermore, improved corrosion resistance, as well as wear resistance increasing the lifetime of the friction members up to the expected life period of the vehicles, is also a task when looking for replacement of the present ferrous materials.

Consequently, several patent applications have been filed world-wide recently disclosing use of PMMC (Particle Metal Matrix Composite, e.g. Al-alloy matrix reinforced by ceramic particles) based components applied for different actual applications in vehicles. Shortcomings in common for all these applications based on PMMC base material are the softening phenomena at elevated temperatures, something which results in scoring and even plastic deformation of the members' surface, thus considerably limiting the maximum allowed operating temperatures of the members. Therefore, as a remedy, it is instrumental to provide the basis PMMC-made friction members either with a special composite/-ceramic coating layer (thermal spraying of ceramics), or with a transfer surface layer.

The provision of an alternative transfer layer requires the layer to be both stable (adherent to the substrate and reliable) and homogeneous. Furthermore, fast formation of the layer having a sufficient thickness is also requested both from a manufacturing, cost and performance point of view.

One feasible way to cope with the task of increasing the maximum operating temperature is simply to increase the volume percentage of reinforcing particles. Unfortunately, two major disadvantages connected to this "solution", namely increased costs of the PMMC base material and difficulties related to production/casting and especially cutting/-machining of the surface, eliminate this as a possibility for a cost efficient manufacturing method.

It is therefore an object of the present invention to provide a novel, fast and cost efficient method of manufacturing friction members avoiding the above mentioned drawbacks and difficulties connected to the hitherto known methods and products.

Another object of the present invention is to provide a fast developing and homogeneous transfer layer exhibiting more stable friction properties, especially at high operating temperatures.

Still another object of the present invention is to provide better protection for the base matrix material against scoring.

These and other objects and features of the present invention are met by provision of a novel manufacturing method of friction members as apparent from claim 1 and the resulting friction member in claim 7, respectively.

The invention will now be described in detail in the following by way of examples of preferred embodiments of the manufacturing method and the resulting members referring to Figures 1-4, where

- Fig. 1 shows in a perspective view a typical disc brake system,
- Fig. 2 illustrates schematically in principle the novel surface topography of the friction member treated in accordance with the present invention,
- Fig. 3 shows a microscope image of an untreated surface, and
- Fig. 4 shows the same surface after exposure to an etching agent as described in the following under Examples.

Referring to Figs. 1 and 2, Fig. 1 shows a disc brake system where the brake disc 1 is the rotating part which together with the friction linings 15 held in place by the caliper 13 creates the friction.

The novel surface treatment according to the invention is applied to the friction surfaces 12 of the disc.

Fig. 2 illustrates schematically a detailed view of the surface of the member (disc) 12 treated in accordance with the present invention.

Contrary to the present practice and trend to add a special surface layer, e.g. in the form of a composite or sprayed ceramic layer, the gist of the present novel treatment method lies in a selective partial removal of the base matrix material from the active to be frictional surface(s) of the member.

The Figure shows in a cross sectional view the (top) surface 2 of the member 1, where the original top layer depicted as 23 has been removed according to the present invention most advantageously by means of chemical etching. This treatment results in a novel surface topography exhibiting a surface with reinforcing (ceramic) particles 22 protruding from the matrix 21, later during the initial break-in activating of the brake system becoming an

integrated part of the transfer layer created through initial wear and material transfer from the lining (pad) material. The resulting increased reinforcement of the transfer layer will provide better protection of the matrix alloy from temperature and shear forces.

Tests conducted on samples of PMMC discs surface treated in accordance with the method confirm formation of a fast developing adherent and homogenous transfer layer exhibiting substantially improved performance characteristics of the treated member.

Furthermore, tests have shown that etching increases the pad wear during the initial use of the disc during the creation of the transfer layer. The degree of etching should therefore be chosen to reach an acceptable initial pad wear. After creation of the transfer layer the actual pad wear falls to a lower level.

Examples

Samples of brake discs made of two different AlSiMg matrix alloys reinforced by SiC particles in an amount of 10 to 30 vol% having a size in a range from 5-30 μ have been subjected to chemical etching applying a solution of NaOH in concentrations from 5-30% up to 20 minutes.

Comparison to the reference samples based on the measurement of surface roughness, friction and performance at elevated temperatures shows improved characteristics on all measured parameters.

A relatively short etching time proved to be adequate to remove a sufficient amount of the aluminium matrix making the SiC particles to protrude from the surface of the brake disc as illustrated by the attached Figs. 3 and 4 showing sample surfaces before and after the etching treatment according to the present invention, respectively.

The actually applied disc samples were made of AlSiMg alloy added 20 weight% of SiC particles.

The surfaces 2 of the samples 1 were exposed for a period of 2 minutes to 12 weight% water solution of NaOH. (Posting 3 depicts an Al-foil applied on the samples as protection of the surfaces prior to microscopic evaluation of the achieved results).

As clearly manifested in Fig. 4, an exposure time of 2 minutes was sufficient to provide an etched surface 2 with SiC particles 4 protruding from the surface 2.

Generally, an etching time from 1-3 minutes and applying 12.5 weight% NaOH solution at room temperature is apparently sufficient to achieve an adequate degree of etching of the surface. Prolonged etching (in excess of 5 minutes) can result in loosening of SiC particles. The temperature and the control of the flow of the etching agent is decisive for the choice of optimal etching time.

The present invention is not limited to the above described examples of the preferred mode of the surface treatment. Thus also other (similar) methods of surface treatment, e.g. electrochemical pickling or chemical etching by means of an appropriate acid, could be applied without departing from the spirit and scope of the present invention. Thus other alkali-based etching agents than the exemplified NaOH, e.g. KOH, could be applied. Also other types of PMMC material applying other reinforcing particles like Al_2O_3 instead of the above described SiC-reinforced Al-matrix are the most actual alternatives.